Soybean Response to Micronutrients Across Minnesota

Fertilizer: Treatments
1) Control (Chk) - no fertilizer
2) Without Zinc (-Zn)
3) Without Manganese (-Mn)
4) Without Molybdenum (-Mo)
5) Without Boron (-B)
6) Without Magnesium (-Mg) (2012 only)
7) Without Chlorine (-Cl) (2012 only)
8) All - 10 lb/ac Zn + 10 lb/ac Mn + 0.5 lb/ac Mo + 0.5 lb/ac B in 2011 or 2 lb B in 2012 + 20 lb/ac Mg + 20 lbs/ac Cl
Phosphorus and Potassium kept at non-limiting levels
Fertilizer was broadcast and incorporated before planting except for Delavan which was managed with no-tillage.

Weed Management: Glyphosate
Experimental Design: Randomized complete block design with 3 to 4 replications

Objective:
The purpose of this study was to determine if there is a potential yield response in soybean to selected micro-nutrients
applied broadcast before planting.

Experimental Methods:
This study used a simple drop out design to study the effects of micronutrients by comparing plots with 4 micronutrients
with plots where one of the particular nutrients are not applied. All treatments were applied in the spring prior to final
field preparation.

Initial soil test results are given in Table 1. Soil phosphorus levels were High to Very High at all locations except for
Roseau ‘12, which tested Medium. Soil potassium ranged from Medium to Very High, and zinc (Zn) was higher than
levels in which deficiencies are likely to occur for corn. Soil tests were also run for manganese (Mn) and boron (B).
There currently are no critical levels for soybean in Minnesota for either nutrient since neither has been shown to be
deficient, similar to Zn. However, high B levels tended to be in sites with higher soil organic matter levels. There were
some exceptions in 2012 but dry soil conditions may have limited B release from soil leading to lower soil test levels.

Table 1. Initial soil test data for 0-6” samples collected before treatment application for soybean micronutrient studies.

<table>
<thead>
<tr>
<th>Location</th>
<th>County</th>
<th>P</th>
<th>K</th>
<th>Zn</th>
<th>Mn</th>
<th>B</th>
<th>Mg</th>
<th>OM</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delavan '11</td>
<td>Faribault</td>
<td>23</td>
<td>150</td>
<td>12.0</td>
<td>46.6</td>
<td>1.1</td>
<td>na</td>
<td>5.2</td>
<td>6.1</td>
</tr>
<tr>
<td>Fosston '11</td>
<td>Polk</td>
<td>25</td>
<td>196</td>
<td>1.1</td>
<td>35.5</td>
<td>1.0</td>
<td>na</td>
<td>7.1</td>
<td>7.5</td>
</tr>
<tr>
<td>Hallock '11</td>
<td>Kittson</td>
<td>30</td>
<td>610</td>
<td>0.8</td>
<td>28.0</td>
<td>1.1</td>
<td>na</td>
<td>8.8</td>
<td>7.0</td>
</tr>
<tr>
<td>Montgomery '11</td>
<td>Rice</td>
<td>121</td>
<td>234</td>
<td>4.6</td>
<td>56.8</td>
<td>0.5</td>
<td>na</td>
<td>3.7</td>
<td>6.2</td>
</tr>
<tr>
<td>Rochester '11</td>
<td>Olmsted</td>
<td>66</td>
<td>185</td>
<td>1.9</td>
<td>53.7</td>
<td>0.4</td>
<td>na</td>
<td>3.2</td>
<td>6.1</td>
</tr>
<tr>
<td>Rock Dell '11</td>
<td>Olmsted</td>
<td>51</td>
<td>130</td>
<td>3.9</td>
<td>24.3</td>
<td>0.8</td>
<td>na</td>
<td>3.2</td>
<td>6.8</td>
</tr>
<tr>
<td>Ada ‘12</td>
<td>Norman</td>
<td>63</td>
<td>255</td>
<td>3.2</td>
<td>9.4</td>
<td>1.2</td>
<td>770</td>
<td>7.9</td>
<td>7.7</td>
</tr>
<tr>
<td>Rochester '12</td>
<td>Olmsted</td>
<td>53</td>
<td>149</td>
<td>2.3</td>
<td>16.6</td>
<td>na</td>
<td>231</td>
<td>2.2</td>
<td>5.7</td>
</tr>
<tr>
<td>Rock Dell '12</td>
<td>Olmsted</td>
<td>51</td>
<td>130</td>
<td>3.9</td>
<td>na</td>
<td>na</td>
<td>3.2</td>
<td>6.8</td>
<td></td>
</tr>
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<td>Roseau '12</td>
<td>Roseau</td>
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<td>126</td>
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<td>13.7</td>
<td>0.4</td>
<td>780</td>
<td>6.2</td>
<td>7.9</td>
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<tr>
<td>Westport '12</td>
<td>Pope</td>
<td>36</td>
<td>148</td>
<td>3.2</td>
<td>18.5</td>
<td>na</td>
<td>432</td>
<td>6.0</td>
<td>6.0</td>
</tr>
</tbody>
</table>

Soybeans are responsive to Mn, however, yield responses are typically seen in areas of the country where soils have been historically deficient in Mn. Research in Michigan has shown soybean yield increases due to Mn and recommendations exist in that state when soil test levels are less than 24 ppm. The only location with a soil test near that level in 2011 was the Rock Dell location, while all 2012 locations were less than that value. Other locations that can exhibit lowered Mn availability are those with high soil pH, but in this case there was no relationship between pH and Mn.
The upper most, fully developed trifoliate was sampled at R2 (full bloom) to assess plant nutrient status at selected sites. Twenty samples were collected and composited from each plot and analyzed for zinc (Zn), manganese (Mn), and boron (B). Leaf molybdenum (Mo) or chlorine (Cl) concentration was not determined. In addition, magnesium (Mg) was sampled. While actually a macronutrient, Mg is touted by some as being needed for maximizing the yield potential for soybean.

Table 2 summarizes the average leaf tissue values for the plots where no micros were applied. In all cases the measured values were considered sufficient indicating that the particular micros were not yield limiting (Sufficiency levels: Mg, 0.26 to 1.00%; Zn, 20-50ppm; Mn, 21 to 100 ppm; B, 21-55 ppm). There were very limited influences of micronutrients on increases in tissue concentration. For most responses the trends do not follow treatment application therefore the data are not shown in this report. One question of interest was about B rates used in 2011. The higher rate caused visual toxicity symptoms at many of the locations. However, these did not result in excessive levels of B in the plant tissue (not shown).

There was no significant effect of the micronutrients studied on yield at any of the locations. Glyphosate application at many of the southern locations was during periods of high temps which did induce some glyphosate flash symptoms in many fields in 2011. In the fields studied there was no advantage to Mn which has been reported to be limiting when glyphosate flash occurs. In addition, soil test Mn levels were lower in 2012 but again there was no yield increase when Mn was applied. There was a significant amount of variability in yields at most locations. However, this variability could not be associated with positive or negative effects on yields due to variability in physical and chemical properties in the soil. The 2-year data summary indicates a yield response to direct application of micro-nutrients and Mg is unlikely for soybean. More data will be collected but it is likely that other factors such as phosphorus or potassium level or soil water availability will limit soybean yield more than micro-nutrients.